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BALLOON, PORTABLE HYDROGEN GENERATOR

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Dear Sir:

This letter report describes the activity under Task Order No. C during April, 1958.

During this period, three 1/10-scale runs were made and calculations were carried out, at your request, on the effect of altitude on lift.

Small-Generator Runs

The data for three additional 1/10-scale runs (Nos. 11, 12, and 13) are listed in Table 1.

TABLE 1. EXPERIMENTAL RESULTS FOR RUNS 11, 12, AND 13
1/10-Scale Runs* (370 cu ft of H_2 under ideal conditions)

Run No.	H_2, cu ft	H_2O, cu ft	Temperature, F		$CoCl_2 \cdot 6H_2O$, lb	Per cent Reaction	Total Generation Time, min
			Initial	Rise			
11	364	11.5	47	36.5	5.56	98.4	34
12	373	11.9	47	29.	4.17	101.	59
13	354	9.2	47	33.	5.15	95.6	41

*Small-generator unit partially immersed in large tank containing 1,100 gallons of water.

These three runs were the first ones performed with the small generator partially immersed in a pool of water, thus simulating generation under field conditions. With this exception, the operating procedures were the same as for previous runs. The purpose of these runs was to attempt to obtain total generation times of 40-45 minutes. The cobalt chloride catalyst concentrations were therefore increased, in these runs, to 4, 3, and 3.7 times the amount indicated by bench-scale studies in the earlier Phase I program.

The principal conclusions from these three runs are:

(1) The reaction can be made to go to completion in a shorter time than the 60-minute maximum period specified, by using increased concentrations of the catalyst.

(2) The water surrounding the generator unit exerts a noticeable cooling effect.

(3) The maximum temperature rise attained at completion of the reaction increases with increasing amounts of catalyst. The increase in ΔT is probably a result of the development of more heat because of the larger amounts of catalyst used, and of the dissipation of less heat to the surrounding pool during the shorter time period.

Check on Delivered Weight of $NaBH_4$

With the completion of Run 13, two 100-lb (nominal) drums of $NaBH_4$ have been used up. The cumulative total weight of $NaBH_4$ charged to the generator in these 13 runs was 202 lb.

Lift Calculations

Tables 2, 3, and 4 summarize the results of calculations of the lift of a balloon filled, from the generator, with 3,500 cu ft (19.64 lb) of hydrogen saturated with water vapor. It was assumed that the temperature rise in the generator was 90 F and that the average temperature of the gas in the balloon, after filling, was 61 F above the initial generator temperature. It was also assumed that the condensed water did not drain from the balloon, and that the weight of the balloon itself was part of the gross load.

The calculations cover three, widely varying conditions. The limiting conditions are given in Tables 2 and 3 for no change in temperature within the gas-filled balloon and for complete equilibration with the surrounding atmosphere, respectively. The results in Tables 3 and 4 show that there is only a very slight effect of altitude on lift when the gas temperature is the same as that of the atmosphere. For this reason, a plot of lift versus altitude has not been prepared.

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TABLE 2. POUNDS OF LIFT AT SEA LEVEL

(No cooling of gases in balloon after filling)

Ambient temperature:	50 F		68 F		86 F	
Humidity of air:	Dry	Saturated	Dry	Saturated	Dry	Saturated
$T_{H_2 + H_2O}$*						
68 F	275.0	273.6	264.8	262.2	255.2	250.8
86 F	287.4	286.0	276.6	274.0	266.6	261.9
104 F	302.1	300.6	290.6	287.7	279.9	274.9
122 F	320.9	319.3	308.4	305.3	296.7	291.3

*$T_{H_2 + H_2O}$ = initial average temperature of the saturated gas in the balloon.

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TABLE 3. POUNDS OF LIFT AT SEA LEVEL

(Gases in balloon reach ambient temperature)

Ambient temperature:	50 F		68 F		86 F	
Humidity of air:	Dry	Saturated	Dry	Saturated	Dry	Saturated
$T_{H_2 + H_2O}$*						
68 F	261.6	260.3	264.8	262.2	265.6	261.0
86 F	257.7	256.4	260.9	258.4	266.6	261.9
104 F	251.2	249.8	254.4	251.8	260.0	255.3
122 F	239.9	238.6	243.1	240.5	248.7	244.0

*$T_{H_2 + H_2O}$ = initial average temperature of the saturated gas in the balloon.

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TABLE 4. POUNDS OF LIFT AT 10,000 FT

(Gases in balloon reach ambient temperature at 10,000 feet)

Ambient temperature:			
At sea level	32 F	50 F	68 F
At 10,000 ft	14 F	28 F	43 F
$T_{H_2 + H_2O}$*			
68 F	259.0	260.4	262.1
86 F	255.2	256.5	258.3
104 F	248.6	249.9	251.7
122 F	237.3	238.6	240.4

*$T_{H_2 + H_2O}$ = initial average temperature of the saturated gas in the balloon.

As currently contemplated, future work will consist of performing a few 1/10-scale runs similar to those described above, but at an initial temperature of 65 F, which is on the high side of the expected service-temperature range.

The total appropriation on this Task Order was $39,375. As of May 1, 1958, the unexpended balance was approximately $4,750.

Sincerely,

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5/23/58

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In Duplicate